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*Fig. III.* is a View of the Mouth open'd to shew,

*a*, the Skin of the Floor of the Mouth, as at *b* in *Fig. II.*

*b*, the Tongue.

*cc*, the external Teeth in the upper and under Jaws, for holding the Prey.

*dd*, the corresponding Clusters of Teeth in the inner cartilaginous Jaw, for Mastication, and tearing the Prey.

*ee*, the *Rictus oris*. *f*, the upper Jaw. *g*, the Entrance into the *gula* and branchial Holes.

*Fig. IV.* is a full View of the Opening into the *Marfupium*, lying under the Fin *d*.

# VIII. *Observations on the Height to which Rockets ascend; by Mr. Benjamin Robins F. R. S.*

Read May 4.  
1749.

THE Use of Rockets is, or may be, so considerable in determining the Position of distant Places to each other, and in giving Signals for naval or military Purposes, that I thought it worth while to examine what Height they usually rise to, the better to determine the Extent of the Country, through which they can be seen. I therefore, at the Exhibition of the late Fire-works, desir'd a Friend of mine, who I knew intended to be only a distant Spectator, to observe the Angle of Elevation to which the greatest Part of them rose, and likewise the Angle made by the Rocket or Rockets, which should rise the highest of all.

My Friend was provided with an Instrument, whose *Radius* was 38 Inches; and, to avoid all Uncertainty in its Motion, it was fixed in an invariable Position; and its Field, which took in ten Degrees of Altitude was divided by horizontal Threads. The Station my Friend chose was on the Top of Dr. *Nisbett's* House in *Kingstreet* near *Cheapside*, where he had a fair View of the upper Part of the Building erected in the *Green Park*. There he observed that the single Rockets which rose the most erect, were usually elevated at their greatest Height about  $60^{\circ}\frac{1}{4}$ . above his Level; and that amongst these there were 3 which rose to  $70^{\circ}\frac{1}{2}$ ; and that in the last great Flight of Rockets, said to be of 6000, the Crest of the Arch, formed by their general Figure, was elevated about  $80^{\circ}\frac{1}{4}$ . From the Care and Dexterity of my Friend, and the Nature of the Instrument, I doubt not but these Observations are true within a few Minutes.

The Distance of this Station from the Building in the *Green Park* is 4000 Yards, according to the last great Map of *London*: And hence it appears, that the customary Height, to which the single, or honorary Rockets, as they are styled, ascended, was near 440 Yards: That three of these rose 526 Yards; and that the greatest Height of any of those fired in the grand Girandole was about 615 Yards: All reckon'd above the Level of the Place of Observation, which I esteem to be near 25 Yards higher than the *Green Park*, and little less than 15 Yards below the Chests whence the great Flight of Rockets was discharged.

It seems then there are Rockets which rise 600 Yards from the Place whence they are discharged: And this being more than a third Part of a Mile, it follows,

follows, that if their Light be sufficiently strong, and the Air be not hazy, they may be seen in a level Country at above 50 Miles Distance.

The Observations on the single Rockets are sufficiently consonant to some Experiments I made myself about a Fortnight since : For then I found that several single Pound Rockets went to various Heights between 450 and 500 Yards, the Altitude of the highest being extremely near this last Number, and the Time of their Ascent usually short of 7".

But though from all these Trials it should seem as if good Rockets of all Sizes had their Heights limited between 400 and 600 Yards ; yet I am disposed to believe, that they may be made to reach much greater Distances. This I in some degree collect from the Nature of their Composition, and the usual imperfect Manner of forming them.

Nor is this merely Matter of Speculation ; for I lately saw a dozen of four Pound Rockets fired ; the greatest Part of which took up near 14" in their Ascent, and were totally obscured in a Cloud near 9 or 10" of the Time ; so that the Moment of their bursting was only observable by a sudden Glimmering through the Clouds : And as these Rockets, during the Time they were visible, were far from moving with a languid Motion, I cannot but conceive, that the extraordinary Time of their Ascent must have been attended by a very unusual Rise.